PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

EP 0026191

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 3: B29C 27/04; F16L 47/02	A1	(11) International Publication Number: WO 80/02124 (43) International Publication Date: 16 October 1980 (16.10.80)

(21) International Application Number: PCT/GB80/00062

(22) International Filing Date: 3 April 1980 (03.04.80)

(31) Priority Application Number: 7912017

(32) Priority Date: 5 April 1979 (05.04.79)

(33) Priority Country: GB

(71) Applicant (*for all designated States except US*): HAXEY ENGINEERING LIMITED [GB/GB]; High Street, Haxey, Doncaster, South Yorkshire, DN9 2HH (GB).

(72) Inventor; and
(75) Inventor/Applicant (*for US only*): RICE, Nigel, Leonard [GB/GB]; Epworth Grange, Beltoft Road, Epworth, Nr. Doncaster, South Yorkshire (GB).

(74) Agents: HARRISON, Michael, Robert et al.; 11th Floor, Tower House, Merrion Way, Leeds, LS2 8PB (GB).

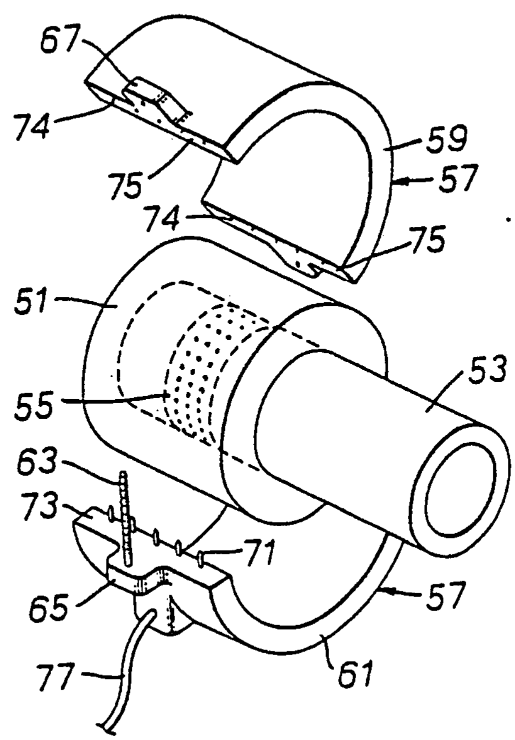
(81) Designated States: AT (European patent), DE (European patent), DK, FR (European patent), GB (European patent), JP, NL (European patent), SE (European patent), US.

Published
With international search report
With amended claims

(54) Title: METHODS FOR JOINING TOGETHER THERMOPLASTICS PIPES AND PIPE FITTINGS

(57) Abstract

A method for joining together two pipes or a pipe (53) and a pipe fitting (51) comprises inducing a current in ferromagnetic material (55) located in the region of the joint to be formed. As a result heat is generated to cause melting of the surrounding thermoplastics material and the joint to be effected. The Curie point of the ferromagnetic material is chosen to lie in the range of temperature suitable for fusion jointing the particular material. The change in magnetic properties of the ferromagnetic material if the temperature exceeds the Curie point can be used automatically to control the jointing process or to indicate to the operator that this temperature has been reached.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria
AU	Australia
BR	Brazil
CF	Central African Republic
CG	Congo
CH	Switzerland
CM	Cameroon
DE	Germany, Federal Republic of
DK	Denmark
FR	France
GA	Gabon
GB	United Kingdom
HU	Hungary
JP	Japan
KP	Democratic People's Republic of Korea
LI	Liechtenstein
LU	Luxembourg
MC	Monaco
MG	Madagascar
MW	Malawi
NL	Netherlands
NO	Norway
RO	Romania
SE	Sweden
SN	Senegal
SU	Soviet Union
TD	Chad
TG	Togo
US	United States of America

METHODS FOR JOINING TOGETHER THERMOPLASTICS PIPES AND PIPE FITTINGS

This invention relates to methods for joining together thermoplastics materials and in particular to methods for joining pipes or pipe fittings to pipes.

It is known to join a pipe fitting to a pipe end by having a metal heating assembly which is used to heat the fitting and the pipe end, and is then withdrawn so that the heated pipe fitting and pipe end may be brought into contact. The fitting and pipe end may be of the spigot and socket type or they may be such that they are to be butt-welded together.

Such a known method is satisfactory in the case of pipes of relatively small diameters but in the case of large diameter pipes there are certain disadvantages. For instance, it may take a long time to remove the heated assembly after the heating stage due to the large size and weight of the heating assembly. By the time the heating assembly has been removed the heated parts of the pipe and pipe fitting may have cooled down so much that the weld cannot be effected. Furthermore, the presence of such a large heating assembly may make the alignment of the pipe fitting with the pipe rather difficult.

It is also known to join together a pipe fitting

to a pipe by means of so-called electro-welding. In this case the fitting has secured thereto a resistance coil or mat which has beeen moulded into the fitting or is located by a post-machining operation. Production of such fittings by means of a moulding operation is difficult and expensive. Whatever the method of production, the ends of the resistance of wire extend from the coil or mat to the exterior of the fitting and can provide a path for crack failure of the fitting.

According to the present invention there is provided a method for joining together two thermoplastics elements, the elements being selected from pipes and pipe fittings, the method comprising bringing together the elements to be joined, there being electrically conductive material located in the region of the joint to be formed, said electrically conductive material being selected to have a Curie point within the range of fusion temperatures which are applicable for the material or materials being joined together, and inducing a current in the conductive material to generate sufficient heat to fuse the elements together.

Accordingly the present invention involves the generation of an induced current in conductive material located in the region of the joint. Accordingly there is avoided the need for leads from the exterior of the fitting to the area to be heated. Furthermore the invention enables the heat generated within the conductive material to be controlled. By selecting conductive material with a Curie point within the range of fusion temperatures which are suitable for the materials to be joined together, the heat generated in the region of the joint can be either automatically or non-automatically controlled. In

particular the conductive material can be formed from an appropriate metal or alloy with a Curie point at or just above the desired welding temperature so that the transformation of the metal or alloy from a ferromagnetic to a paramagnetic can be utilised. For instance, where the transformation itself affects the amount of heat generated within the conductive material then an automatic control of the heating is provided. Thus if the material reaches a temperature above the Curie point then the amount of heat being generated is immediately reduced and the material cools. Alternatively or in addition, the change in the magnetic properties of the material may be detected and when such change takes place the current in the conductive material can be reduced by, for instance, reducing the output of the radio frequency generator. The means for detecting the change in magnetic properties may form part of a system allowing automatic control of the induced current in the conductive material.

A method in accordance with the present invention may be applied to any form of joints between pipes and further pipes or pipe fittings, for instance to spigot and socket type joints and to butt joints as well as saddle joints.

The conductive material may be in the form of a ring surrounding the entire circumference of the inner of the members to be joined together. Alternatively it may be in the form of a strip or other piece which is incorporated between merely a portion of the circumference of the members being jointed together, for instance, in the case of a pipe of large diameter.

One or more rings of conductive material may be located between the surfaces to be joined. For instance, in the case of a spigot and socket fitting

one or more grooves may be cut in the socket of the fitting. Then a ring of conductive material may be fitted in the or each groove.

With the conductive material in position, either located between the two elements to be joined together or affixed or integral with one of these elements, the area to be jointed is surrounded by the work coil of an induction generator. The generator and work coil should be such as to generate a uniform magnetic field throughout the joint area.

The work coil may consist of, for instance, one to ten turns of conductive material, the number of turns being dependent upon the particular application. In a preferred embodiment the work coil is located within a clamp which is used to hold together the elements to be jointed. More preferably the clamp is a split clamp, the two halves of which are fitted with electrically conductive pins and sockets. Accordingly the coil holder not only carries the coil for the generation of the inductive field but also acts to grip the fitting and, either alone or in conjunction with further clamps, "re-rounds" the pipe where the pipe is distorted from true circularity.

Preferably the output frequency is in the region of 10 to 500 KHz, the particular frequency depending upon the specific application.

The conductive material may be a ring of a metal or alloy which is preferably provided with perforations or holes. The use of such perforated material enables the fused plastics material to flow into the holes and so form a strong joint in the region of the conductive material. The conductive material may, for instance, be in the form of a ring which is pre-coated with a suitable polymeric coating to effect a "molecular bond"

to the ring and to be compatible for fusion with the material of the pipe and the pipe fitting.

The elements to be joined together may be made of the same or different materials. For instance, one element may be made of one form of polyethylene and the other element may be made of a different polyethylene. Alternatively one element may be made of polyethylene and the other element may be made of polypropylene. Whether the materials are the same or different there will in practice be a range of temperature over which fusion jointing can satisfactorily take place and the conductive material should be chosen so that its Curie point lies within this range. For instance, where the materials to be jointed together are polyethylene, a suitable range may be from 230 to 280°C, preferably from 250 to 270°C. Where the elements to be jointed together are made of polypropylene, the temperature range may suitably be from 250 to 300°C, preferably from 260 to 290°C.

The range of suitable fusion temperature will normally depend upon several factors. Thus the temperature must be above the minimum melt point for the material, or materials, of the elements. However, it must also be sufficiently high for the material to flow to an extent sufficient to effect a good joint. This may depend on the fusion pressure. The fusion pressure may arise due to pressure applied externally through the clamping arrangement and/or to pressure arising due to the expansion of the heated elements within the clamping arrangement.

The fusion temperature should not be above the temperature where degradation of the thermoplastics material takes place. This is a temperature above which the crystallinity of the material is affected.

A particular application of the method of the present invention is in repairing buried pipelines. With current methods of butt fusion or spigot and socket fusion, the pipe ends must be moved axially to form the joint and accordingly considerable excavation of the pipe is required. However, using a method of the present invention, one cut pipe end may be moved radially and a sleeve containing conductive rings may then be slid over this pipe end. The pipe ends are then brought together and the sleeve moved to a central position over the point to be formed. The weld is then effected by inducing currents in the conductive rings.

Embodiments of the present invention will now be described by way of examples only, and with reference to the accompanying drawings, in which:-

Figure 1 is a diagrammatic view illustrating the welding of a T-fitting to a pipe;

Figure 2 is a perspective view showing a method of the invention being applied to the formation of a saddle joint;

Figure 3 is a further perspective view, in this case from the pipe end of the arrangement illustrated in Figure 2;

Figure 4 is a perspective view showing the application of a method of the present invention to the jointing together of a pipe and a loose socket; and

Figure 5 is a further view of the arrangement of Figure 4 but with the clamp parts in the process of being closed together.

Referring to Figure 1 of the drawings, a T-fitting 1 is intended to make a spigot and socket joint with the end of a pipe 3. An annular groove 5 has been

machined into the interior surface of the socket portion 7 of T-fitting 1 and a ring of conductive material 9 has been located in groove 5. The conductive material 9 is a thermoplastics polymer having embedded homogeneously therethrough a metal powder. The metal is a ferromagnetic and has a Curie point within the range of temperature where fusion between T-fitting 1 and pipe 3 satisfactorily takes place.

With the end of pipe 3 located in position in socket portion 7 of T-fitting 1, the work coil 11 of an induction generator is located around the area to be joined together. The generator is then operated to cause a magnetic field, which alternates at a frequency within the range 10 to 500 KHz, to pass through conductive material 9. This causes an electric current to be generated in the material 9 so the material 9 is heated. The material 9 melts at its fusion temperature as does also the neighbouring material of socket portion 7 and the end of pipe 3. The induction generator is then switched off and on cooling a uniform weld results.

Should the temperature of the conductive ring 9 exceed the Curie point of the metal powder contained therein, the metal transforms from a ferromagnetic to a paramagnetic and the amount of heat generated is immediately reduced. Accordingly the temperature is automatically controlled so as not to exceed a temperature above which degradation of the polymeric material of the T-fitting 1 and/or the pipe 3 takes place.

The conductive ring 9 may, in an alternative embodiment, be a ring of perforated ferromagnetic material such as Radiometal. Radiometal is an alloy

manufactured by Telcon and is a nickel-iron alloy with about 36% nickel. Strips of Radiometal may be punched to provide the perforations and then the ends butt-welded together to form a loop or ring. This material does not give rise to corrosion problems because of the high nickel content. Radiometal 35 has a Curie point of about 275°C which is appropriate for fusion together of, for instance, a polypropylene T-fitting to a polypropylene pipe.

Referring to Figures 2 and 3 of the accompanying drawings, a saddle 21 of thermoplastics material is to be welded to a pipe 23 made of the same or a similar thermoplastics material. Saddle 21 is located at the desired position on pipe 23 with a shaped ring 25 of perforated ferromagnetic metal lying therebetween. The ring 25 may be either integral or non-integral with saddle 21. It can, for instance, be permanently secured to the saddle 21 by locating the saddle over the ring 25 on the heated mandrel so as to soften the thermoplastics material of the saddle and embed the ring ring therin.

As illustrated in Figure 2, the ring 25 of ferromagnetic material surrounds the branch portion 27 of the saddle so that it covers the area of the saddle which it is desired to fuse to the pipe 23.

With the saddle 21 and conductive ring 25 in position on pipe 23, a clamp 29 is then applied over saddle 21. Clamp 29 comprises two portions 31, 33 hinged together at 35, the two portions 31, 33 being closable together by means of the location of clamp hold 37, extending from lug 39 of clamp portion 31, through bore 41 of lug 43 which is integral with portion 33 of the clamp. With the clamp 29 in position branch portion 27 protrudes through hole 45

in portion 33 of the clamp. Tightening of bolt 37 will cause the clamp firmly to grip and hold together the pipe 23 and saddle 21.

Located within portion 33 of clamp 29 is an electric coil 47 which may be fed with an electric current by means of cable 49 leading to a generator (not shown). Coil 47 is positioned so that, with the clamp located about pipe 23 and saddle 21, coil 47 overlies the ring 25 of conductive metal.

The Curie point of the metal of ring 25 is in the range of temperature which is suitable for the fusion together of saddle 21 and pipe 23. Accordingly when current is passed through coil 47, the magnetic field generated in ring 25 causes the ring and the surrounding thermoplastics material (of both the saddle 21 and the pipe 23) to heat to fusion temperature. The thermoplastics material of the saddle 21 and pipe 23 flow together and through the perforations in ring 25. If the temperature of ring 25 rises above the Curie point of the material, then the material changes from a ferromagentic to a paramagnetic and the heat generated decreases. Accordingly there is an automatic control of the fusion temperature.

When heating has taken place for a sufficient time the generator is switched off and, on cooling, a uniform weld results between the saddle 21 and pipe 23.

Referring to Figures 4 and 5 of the accompanying drawings, there is illustrated the jointing of a loose socket 51 to a pipe 53. Loose socket 51 has adhered to its inner surface a ring 55 of perforated ferromagnetic metal. In fact socket 51 may be provided with two axially spaced apart rings such as ring 55 so that the socket may be jointed not only to

pipe 53 but to a further pipe so as to effect a connection between two pipes.

As in the case of the method described with reference to Figures 2 and 3, a combined clamp and coil holder 57 is used. However, in this case clamp 57 is in the form of two separate half clamps 59 and 61 which may be secured together by means of screws 63 extending from lugs 65 on half clamp 61 through holes in lugs 67 of half clamp 59 and secured by means of ring nuts 69.

Located within clamp 59 is a work coil having five turns, each half clamp 59, 61 carrying five half turns of the work coil. When the half clamps 59, 61 are closed together, conductive pins 71 extending from mating faces 73 of half clamp 61 fit into sockets 74 in mating surfaces 75 of half clamp 59, thereby forming the complete work coil.

With the half clamps 59, 61 mated together about socket 51, the socket 51 and pipe 53 are fusion jointed together in the manner described above in connection with Figures 2 and 3. As in the case of the method described with reference to Figures 2 and 3, the Curie point of the metal of ring 55 is in the range of temperature which is suitable for the fusion together of socket 51 and pipe 53.

CLAIMS:

1. A method for joining together two thermoplastics elements, the elements being selected from pipes and pipe fittings, the method characterised by bringing together the elements to be joined, there being electrically conductive material located in the region of the joint to be formed, said electrically conductive material being selected to have a Curie point within the range of fusion temperatures which are applicable for the material or materials being joined together, and inducing a current in the conductive material to generate sufficient heat to fuse the elements together.

2. A method according to claim 1 characterised in that the Curie point of the conductive material lies in the range from 200 to 300°C.

3. A method according to claim 1 characterised/ in that the elements to be joined together are made of polyethylene and the Curie point of the conductive material is in the range of from 230 to 280°C

4. A method according to claim 3 characterised in that the Curie point of the conductive material lies in the range 250 to 270°C.

5. A method according to claim 1 characterised in that the elements to be joined together are made of polypropylene and the Curie point of the conductive material lies in the range 250 to 300°C.

6. A method according to claim 5 characterised in that the Curie point of the conductive material lies in the range of from 260 to 290°C.

7. A method according to any of the preceding claims characterised in that the conductive material is in the form of a strip of perforated metal.

8. A method according to any of the preceding claims characterised in that the elements to be joined together are held together by clamping means, said clamping means also carrying the work coil of an induction generator.

9. A method according to any of the preceding claims characterised in that a current is induced in the conductive material by means of an induction generator whose output frequency is in the region of 10 to 500 KHz.

AMENDED CLAIMS
(received by the International Bureau on 15 September 1980 (15.09.80))

1. A method for joining together two thermoplastics elements, the elements being selected from pipes and pipe fittings, the method characterised by bringing together the elements to be joined, there being a strip of perforated electrically conductive material located between the surfaces to be joined, said electrically conductive material being selected to have a Curie point within the range of fusion temperature which are applicable for the material or materials being joined together, and inducing a current in the conductive material to generate sufficient heat to fuse the elements together.

2. A method according to claim 1 characterised in that the Curie point of the conductive material lies in the range from 200 to 300°C.

3. A method according to claim 1 characterised in that the elements to be joined together are made of polyethylene and the Curie point of the conductive material is in the range of from 230 to 280°C.

4. A method according to claim 3 characterised in that the Curie point of the conductive material lies in the range 250 to 270°C.

5. A method according to claim 1 characterised in that the elements to be joined together are made of polypropylene and the Curie point of the conductive material lies in the range 250 to 300°C.

6. A method according to claim 5 characterised in that the Curie point of the conductive material lies in the range of from 260 to 290°C.

7. A method according to any of the preceding claims characterised in that the conductive material is metal.

8. A method according to any of the preceding claims characterised in that the elements to be joined together are held together by clamping means, said clamping means also carrying the work coil of an induction generator.

9. A method according to any of the preceding claims characterised in that the current is induced in the conductive material by means of an induction generator whose output frequency is in the region of 10 to 500 KHz.

FIG.1.

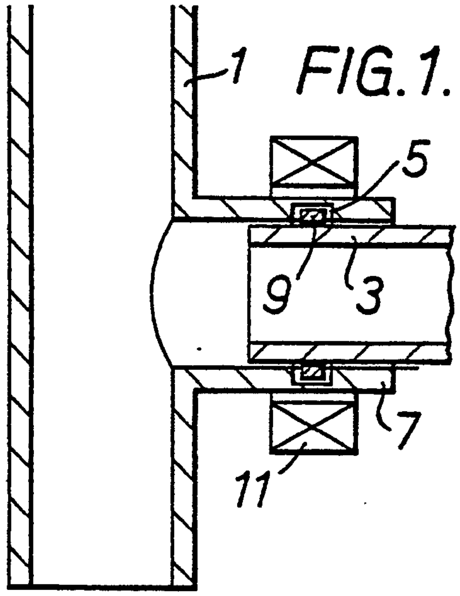


FIG. 2.

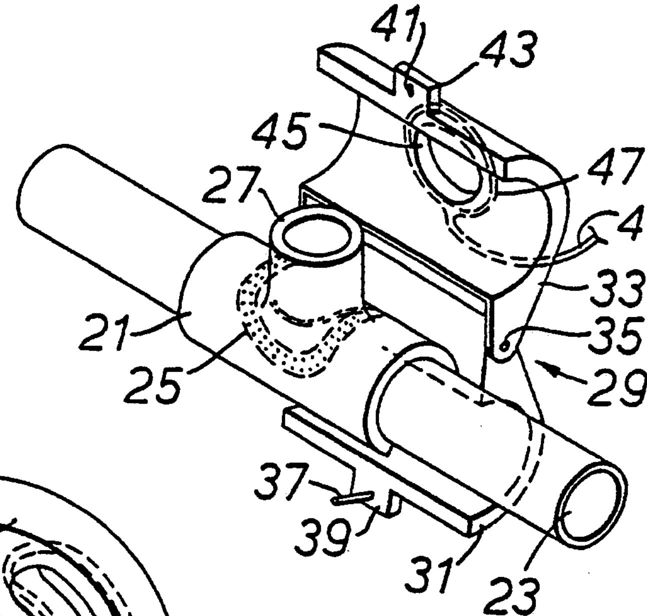


FIG.3.

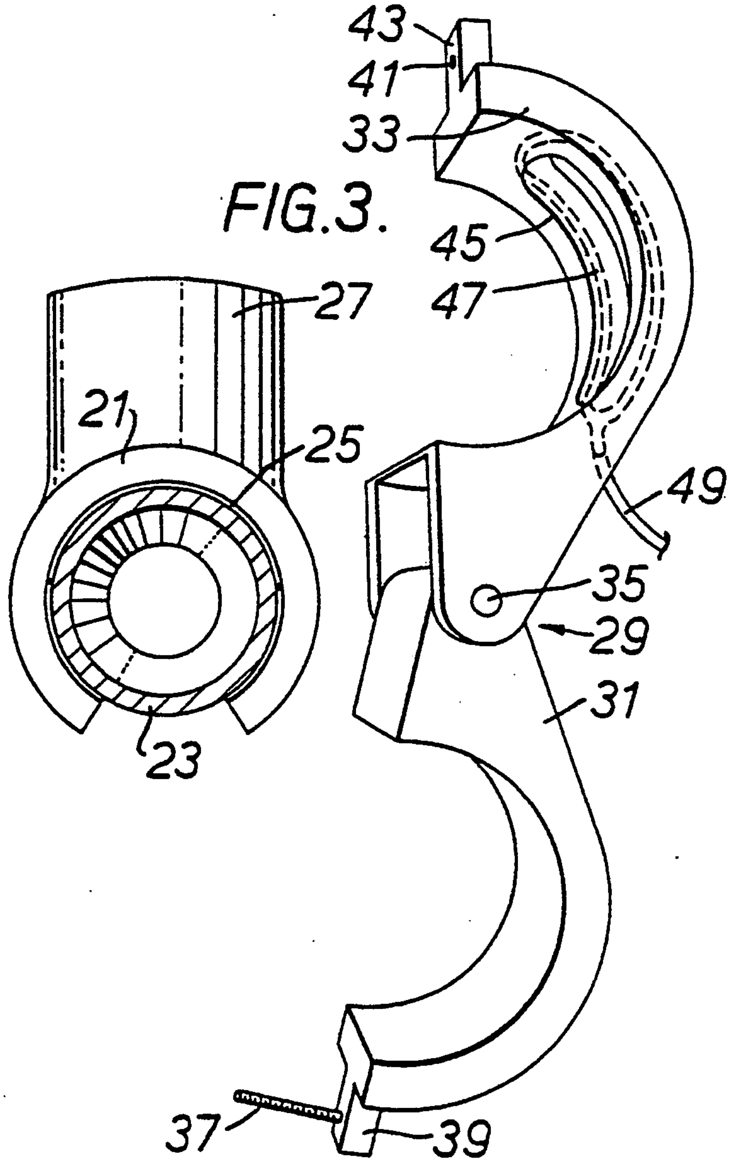


FIG. 4.

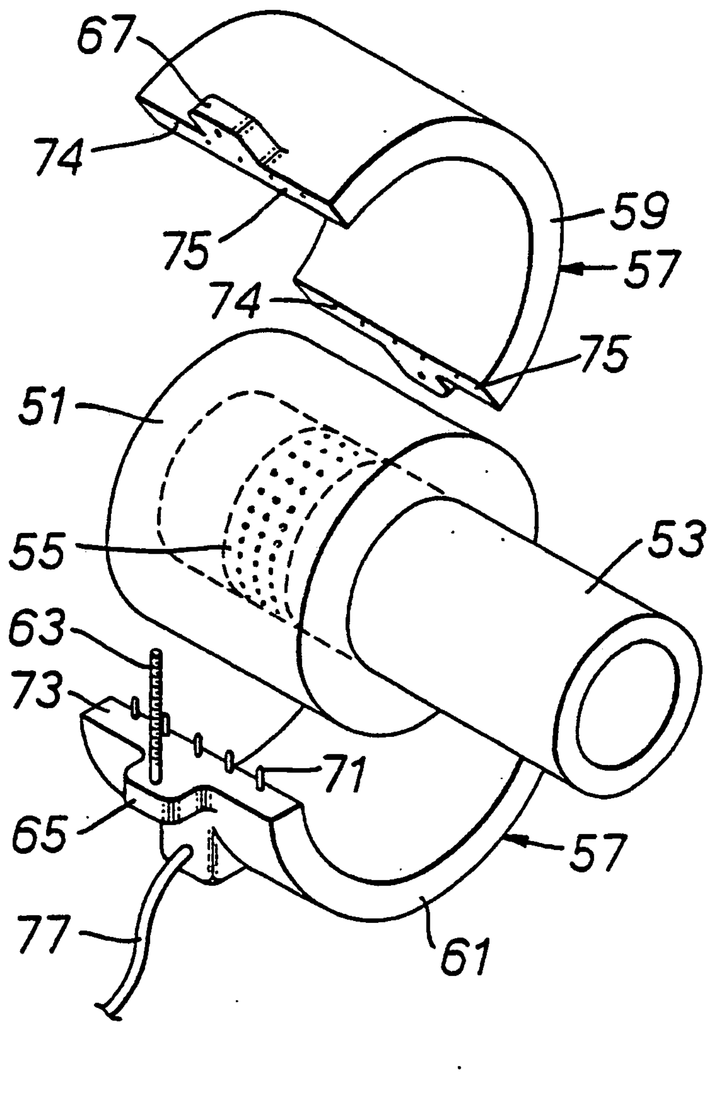
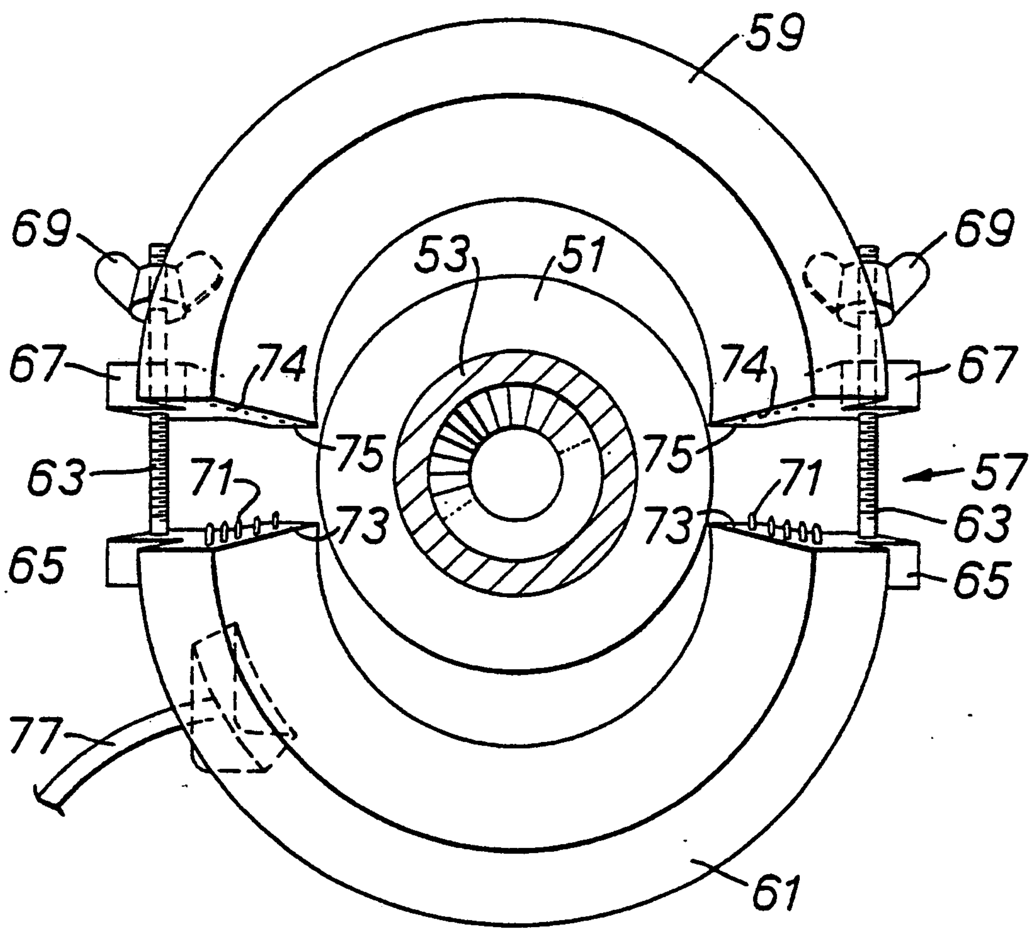


FIG. 5.



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 80/00062

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.^{3}: B 29 C 27/04; F 16 L 47/02

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
Int. Cl.^{3}	B 29 C; F 16 L

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
	US, A, 2393541, published January 22, 1946 see the whole document, F. Kohler	1-9
	US, A, 2739829, published March 27, 1956 see figures, claim 1, Pedlow	7
	FR, A, 2330595, published June 3, 1977 see figure 6, page 6, lines 20-34, Rheem Manufacturing Company	8
A	Derwent Abstracts, Soviet-Inventions Illustrated-Section I Chemical, volume 22, issued 1974, July 5. (London GB), V.A. Sudnik et al., "Butt pressure welding machine", see Metallurgy page 21, Week V 23, the abstract no. 1447985/25-27 of SU, A, 396220	
A	Derwent Abstracts, Soviet-Inventions Illustrated-Section I Chemical, volume 22, issued 1974, July 5 (London GB), V.P. Voinov et al., "Pressure welding process control", see Metallurgy page 21, Week V 23, the abstract no. 1672110/25-27 of SU, A, 396218	

* Special categories of cited documents: [15]

"A" document defining the general state of the art

"E" earlier document but published on or after the international filing date

"L" document cited for special reason other than those referred to in the other categories

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed

"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
July 3, 1980	July 15, 1980
International Searching Authority [1]	**Signature of Authorized Officer [20]**
European Patent Office	G.L.M. KRUYDENBERG